NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND

(No.)
Code 378

DEFINITION

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by combining the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at spillway elevation is 3 feet or more.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To provide water for livestock.
- Fish and wildlife.
- Recreation.
- Fire protection.
- Irrigation.
- Crop and orchard spraying.
- To maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
2. The product of the storage (acre-ft) times the effective height (ft) of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.
3. The effective height of the dam is 35 ft or less, and the dam is hazard class (a).

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and an emergency spillway, or (3) a principal spillway.

Drainage area. The drainage area contributing to the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water in the pond for the

intended purpose. The water quality shall be suitable for the intended use.

Reservoir area. The topography and soils of the site shall permit storage of water at a depth and volume that ensures a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

CRITERIA

General Criteria Applicable to All Purposes

All planned work shall comply with all Federal, state, and local laws and regulations. Ponds may need to be approved or permitted by the appropriate Florida Water Management District (WMD) other permitting agency.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. Areas shall be vegetated in accordance with NRCS Florida conservation practice standard for Critical Area Planting, Code 342.

Visual resource design. The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

CRITERIA FOR EMBANKMENT PONDS

Site Investigation. Field soil borings will be made in the embankment foundation, emergency spillway, and any borrow locations. Borings for the embankment are usually along the centerline and used to determine if an adequate cutoff can be constructed. Borings in the emergency spillway and borrow areas are used to determine the adequacy of material to be used in the foundation cutoff trench and embankment. A permanent record of all soil borings and test pits made in the reservoir area, embankment foundation, borrow area, and emergency spillway area shall be maintained in the design folder.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and shall be deep enough to extend into a relatively impervious layer (minimum of 1 foot) and provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes of the cutoff trench shall be safe and in no case shall be not be steeper than one horizontal to one vertical (1:1).

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

Earth embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

Table 1 - Minimum top width for dams

Total height of embankment, ft	Top width, ft
< 10	6
10 to < 15	8
15 to < 20	10
20 to < 25	12
25 to < 35	14
35	15

Side slope. The combined upstream and downstream side slopes of the settled embankments shall not be less than that shown in Table 2. Neither slope shall be steeper than two horizontal to one vertical (2:1). All slopes must be designed to be stable, even if flatter side slopes are required. Dams to be mowed should have three horizontal to one vertical (3:1) side slopes or flatter.

Wave protection. Where needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (see NRCS Technical Releases 56 and 69).

Table 2 - Side Slope Based on Embankment Material

Embankment Material	Minimum Combined Slopes, Horizontal to Vertical
Clayey Sand (CL)	5:1
Sandy Clay (SC)	5:1
Silty Clay (CL)	5:1
Silty Sand (SM)	5:1
Clayey Gravel (GC)	5:1
Silty Gravel (GM)	5:1
Silt (ML)	6:1
Clay (CH)	6:1
Clayey Silts (MH)	6:1
Fine Sand (SM-SP)	8 to 1 (Minimum 3.5 to 1 side slope on one side)

Freeboard. The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20 acre drainage area or more than 20 feet in effective height.

Settlement. The design height of the dam shall be increased by the amount needed to ensure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate and the quality assurance during construction determines that the required compaction is obtained.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway without erosion. Vegetated or earth spillways will not be adequate without a pipe spillway if long duration, continuous, or frequent flows are expected.

The principal spillway crest elevation shall be no less than 0.5 foot below the crest of the emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 foot for those having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillway. The diameter of the pipe shall not be less than 6 inches. All pipe sizes may be considered when the routed design hydrograph is used to design the emergency spillway.

Pipe conduits under or through the dam shall be capable of withstanding external loading without yielding, buckling, or cracking and must be watertight. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. Total pipe length shall include a minimum of 4 feet added to extend beyond the downstream embankment toe.

For dams 20 feet or less in effective height, acceptable pipe materials are cast-iron, welded steel, corrugated steel or aluminum, concrete, plastic including polyvinyl chloride (PVC) and high density polyethylene (HDPE), and cast-in-place reinforced concrete. Plastic pipe that will be exposed to direct sunlight should be made of ultraviolet resistant materials or be protected by coating or shielding; or provisions made as necessary for replacement. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 feet in effective height, conduits shall be reinforced concrete pipe, cast-in-place reinforced concrete, corrugated steel or aluminum, or welded steel pipe.

PVC and HDPE pipe shall meet the requirements in Table 3 and steel and aluminum pipe shall meet the requirements in Table 4.

The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when

needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe, non-eroding outlet.

Table 3.- Acceptable plastic pipe for use in earth dams1/

Type of plastic pipe	Nominal pipe size, in	Maximum depth of fill over pipe, ft
SDR 26 (160 psi) 1/	6 - 12	10
Schedule 40 (180 psi) 1/	6 - 12	10
Schedule 80 (280 psi) 1/	6 - 12	15
PVC 2/	4 - 18	15
PVC 2/	24 - 36	10
HDPE 2/	4 - 18	15
HDPE 2/	24 - 36	10

1/ Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ATSM-D1785 or ATSM-D2241.

2/ Polyethylene, Type III, Class C, Category 4 or 5 conforming to ASTM D1248 and D3350 and AASHTO M252 or M294, Type S: PVC; ASTM F949.

Protective coatings of asphalt or polymer on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5.

Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be used on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need. NRCS conservation practice standard 430-FF provides criteria for cathodic protection of welded steel pipe.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1.25 inches.

The pipe conduit shall have a minimum slope of 0.5 foot per 100 feet (after foundation settlement) to provide positive drainage.

Siphon Pipe Spillways. A siphon pipe spillway is a closed conduit system formed in the shape of an inverted U, positioned so that the inside (invert) of the bend of the upper passageway is at normal water surface level. The initial discharge of the siphon pipe spillway, as the reservoir level rises above normal , are similar to flow over a weir. Siphonic action takes place after the air in the bend over the crest has been exhausted. Continuos flow is maintained by the suction effect due to the gravity pull of the water in the lower leg (downstream) of the siphon. After it primes, flow in a siphon pipe spillway is comparable to that in a culvert spillway (hooded inlet spillway).

A siphon-breaker air vent is provided to control the siphonic action of the spillway so that it will cease operation when the reservoir water surface is drawn down to normal level. Otherwise, the siphon will continue to operate until air enters the inlet. The minimum size of siphon-breaker air vent shall be 2 inches for siphon pipes less than 8 inches in diameter. For siphon pipes 8 inches or larger in diameter, the minimum air vent pipe shall be 4 inches in diameter.

Because of the negative pressures prevalent in the siphon, the pipe should be sufficiently rigid to withstand the collapsing forces. Collapsing of the siphon pipe can occur whenever the residual pressure in the pipe is less than atmospheric pressure. In order to prevent absolute pressures within the conduit from approaching cavitation or collapsing pressures, the total drop of the siphon will be limited to a maximum of 20 feet.

The pipe joints must be sealed to prevent the introduction of air or soil particles in the siphon as a result of the negative pressures. Pipe joints, using “O” rings or gasket seals rated as watertight up to 5 psi, may not provide sufficient airtightness to function properly in a siphon pipe spillway.

The inlet end of the siphon must have sufficient area to supply the flow without restriction. The inlet must be enlarged or perforated to equal four times the area of the siphon pipe. The end of the pipe must be protected from clogging by an appropriate trash rack.

The outlet end of the siphon (10 to 20 feet of the lower downstream leg) shall have a minimum adverse grade equal to twice the diameter of the siphon pipe. Installation of a concrete thrust block

is recommended at the bend for this grade change.

Seepage control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

The drainage diaphragm is to consist of sand, meeting fine concrete aggregate requirements in ASTM C-33 (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made. The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the pipe diameter, as measured from the outside of the pipe, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench and approximately parallel to the centerline of the dam.

The drain shall outlet at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protecting drain fill from surface erosion will be necessary.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall not exceed 14 times the minimum projection of the antiseep collar measured perpendicular to the pipe. Antiseep collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase the seepage path along the pipe by a minimum of 15%.

Antivortex devices. Closed conduit spillways designed for pressure flow must have adequate antivortex devices. Antivortex devices shall be designed in accordance with ARS-NC-33, Hydraulics of Closed Conduit Spillways, Part XIV.

Trash guard. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser. The trash guard shall be designed and constructed in such a manner that flow to the inlet will not be adversely affected.

Emergency spillways. An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The minimum criteria for the use of a closed conduit principal spillway without an emergency spillway is as follows:

1. a closed conduit with a cross-sectional area of 3 square feet or more,
2. an inlet that will not clog, and
3. an elbow designed to facilitate the passage of trash

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow or routed hydrograph expected from a design storm of the frequency and duration shown in Table 5. All principal spillway pipe sizes can be routed.

The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower.

Emergency spillways shall provide for passing the design flow at a nonerosive velocity to a point downstream where the dam will not be endangered. Constructed emergency spillways are open channels that consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the emergency spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural emergency spillways. If chutes or drops are used for principal spillways or emergency spillways, they shall be designed according to the principles set forth in the National Engineering Field Handbook for Conservation Practices and the National Engineering Handbook-Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 5, less any reduction creditable to conduit discharge and detention storage.

EXCAVATED PONDS

Site Investigation. Site suitability and design shall be based on adequate investigations and surveys as described in the National Engineering Field Handbook for Conservation Practices, Chapter 11, Ponds and Reservoirs.

Runoff. Provisions shall be made for a pipe and emergency spillway if necessary. Runoff flow patterns and ground water recharge rate shall be considered when locating the excavated pond and placing the spoil (see Table 5).

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical (1:1). If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to a depth of 3 feet below the anticipated low water elevation at a slope no steeper than four horizontal to one vertical (4:1).

Perimeter form. If ponds are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Table 4.- Minimum gage for corrugated metal pipe [2-2/3-in x ½-in corrugations][1/]

Fill height (ft)	Min. gauge for steel pipe					Min. thickness (in) of aluminum pipe [2/]			
	Diameter in inches					Diameter in inches			
	≥ 24	30	36	42	48	≥ 21	24	30	36
1 to < 15	16	16	14	12	10	0.06	0.06	0.075	0.075
15 to < 20	16	16	14	12	10	0.06	0.075	0.105	0.105
20 to ≤ 25	16	14	12	10	10	0.06	0.105	0.135	----[3/]

1/ Pipe with 6-, 8-, and 10-inch diameters has 1-1/2 in x ¼-in corrugations.

2/ Riveted or helical fabrication.

3/ Not permitted.

Table 5.-Minimum spillway capacity

			Minimum design storm frequency [2/]		
Drainage	Effective height	Storage	Principal	Emergency	Minimum
acre	ft	ac-ft	yr	yr	hr
⇔ 20	⇔ 20	< 50	2	10	24
⇔ 20	> 20	< 50	2	25	24
> 20 to ⇔ 100	⇔ 20	< 50	2	25	24
> 20 to ⇔ 100	> 20	< 50	2	50	24
> 100 to < 250	⇔ 20	< 50	5	25	24
> 100 to < 250	> 20	< 50	5	50	24
⇩250	⇔ 20	< 50	10	25	24
All Others			10	50	24

1/. As defined under “Conditions”

2/ Select rain distribution based on climatological region

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not erode back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment and leveling.
5. Hauled away.

Additional Criteria for Providing Livestock Water

The required storage shall be calculated using 1.5 times the sum of the following:

1. The specified minimum gallons per animal per day as stated in NRCS conservation practice standard Trough or Tank, Code 614 for the estimated number of days to be used.
2. The net evaporation loss for the design days of storage.
3. Seepage loss based on the best available data.

Additional Criteria for Fish and Wildlife

The reservoir shall be designed for a maximum amount of water in excess of three feet in depth. Management of ponds for fish production shall be in accordance with NRCS conservation practice standard Fish Pond Management, Code 399.

Additional Criteria for Recreation

The volume of water should be sufficient to exceed evaporation and seepage losses and maintain a desirable water level. The water must be free of pollution, especially where it is to be used for swimming.

Additional Criteria for Fire Protection

Fire protection shall be incorporated into the structure design by incorporating an underground piping system which connects the reservoir to a dry hydrant. Minimum water storage, location of intake pipe, etc., shall meet the requirement of Florida NRCS conservation practice standard Dry Hydrant, Code 205. The pump shall be of sufficient capacity and hoses shall be of sufficient length to reach the structures to be protected.

Additional Criteria for Irrigation

The capacity of the pond shall be adequate to meet the irrigation requirement of the planned crop(s). The required capacity shall be based on the irrigation requirements of the crops to be irrigated, the effective rainfall expected during the growing season, the application efficiency of the irrigation method used, the losses due to evaporation and seepage, and the expected inflow into the pond.

Additional storage shall be provided for the estimated volume of sediment that will be deposited during the life of the structure.

Additional Criteria for Crop and Orchard Spraying

The volume of water in the pond shall exceed the anticipated amount of water needed for spray applications and must be available when needed.

Suitable means should be provided to convey water from the pond to the spray tank. To prevent contamination of the water supply from the spray tank into which chemicals are injected, the design must incorporate backflow prevention equipment as required by Chapters 487.064 F.A.C. (pesticides) and 567.087 F.A.C. (fertilizers).

Chemigation shall be applied in conformance with NRCS FL conservation practice standards Nutrient Management, Code 590 and Pest Management, Code 595.

Additional Criteria for Maintaining and Improving Water Quality

Water quality problems include sediment, fertilizers, pesticides, litter, oils, and solvents. A reduction of peak flows to a receiving stream or water body will slow water flow and thereby carry less suspended solids. Ponds designed for water quality improvement of downstream water bodies shall be designed so that the first flush of a storm event will be retained within the pond and later storm water flow will be the first flows released through the principal spillway. In addition, the pond will be designed with a permanent pool deep enough to hold water all year and with shallow areas (littoral zones) with dense vegetation. These practices will increase sedimentation of suspended solids, reduce resuspension of

sediments by wave action, remove floating debris from storm water, and aid in mosquito control.

CONSIDERATIONS

Ponds will affect the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge. Generally the peak discharge will be reduced and in many instances reduced to zero during dry periods that could affect other water uses or users. There may be an increase in recharge to the ground water since most ponds seep and the base flow may extend for a longer period of time. Effects on the volume of downstream flow may prohibit undesirable environmental, social or economic effects.

Ponds have the potential for multiple uses. Storage requirements for each purpose should be considered to ensure an adequate water supply for all intended uses. Ponds used for multiple uses should be compatible.

Properly designed ponds will trap nutrients, sediments and pesticides. Therefore chemical concentrations will normally be higher in the pond area and lower in the downstream channel section.

This practice will affect the visual quality of onsite and downstream water resources. The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Short-term and construction-related effects of this practice may affect the quality of downstream water courses.

Surface water temperature of the pond will increase and may affect the temperatures of downstream water and cause undesired affects on aquatic and wildlife communities.

Ponds constructed in upland areas may have a positive affect on wildlife habitats.

Ponds constructed in wetland areas must be evaluated to ensure the net wetland benefits are maintained or increased.

Where water must be conveyed for use elsewhere, such as for irrigation or fire protection, ponds should be located as close to the point of use as feasible.

Ponds used for public recreation should have minimum facilities such as access roads, parking areas, boat ramps or docks, and drinking and sanitary facilities. Where areas are used for swimming, safety signs should be installed indicating the depth of water and flatter side slopes should be installed for safety. Water should be tested for quality on a regular basis.

During the construction of ponds, there is the potential for earth moving to uncover or redistribute toxic materials.

Due consideration should be given to economics and safety and health factors.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Copies of the plans and specifications shall be given to the landuser.

OPERATION AND MAINTENANCE

An operation and maintenance plan will be made for each structure site and given to the landuser. All ponds must be adequately maintained if their purposes are to be realized through the expected life. Special considerations shall be given for maintenance needs during the planning, design, and construction of the pond.

The pond should be inspected periodically and especially after heavy rains to determine whether it is functioning properly or if repairs are needed.

Appurtenances such as trashracks, outlet structures, and valves shall be kept free of trash and replaced when needed.

Rills on the slopes of the dam and eroded areas in the earth spillway shall be filled with suitable material, compacted, seeded and fertilized as needed. Should the upstream face of the dam erode due to wave action, protection such as riprap may be needed. If seepage through or under the dam occurs, proper corrective measures shall be taken immediately.

The vegetative cover of the dam and earth spillway shall be maintained by mowing and fertilizing or burning when needed. Trees can cause leaks and safety hazards and should not be

permitted on the embankment or in the emergency spillway.

When needed, fencing and watering troughs will be provided to protect the pond and vegetation from livestock.

REFERENCES

ARS-NC-33, Hydraulics of Closed Conduit Spillways, Part XIV
Chapters 487.064 F.A.C. (pesticides) and 567.087 F.A.C.
NRCS Technical Release 56, 59, 60, 69
National Engineering Field Handbook, Chapter 11
National Engineering Handbook, Section 5
National Engineering Handbook, Section 11
National Engineering Handbook, Section 14
NRCS Conservation Practice Standards
Critical Area Planting, Code 342
Dry Hydrant, Code 205
Fish Pond Management, Code 399
Irrigation Water Conveyance, Steel, 430-FF
Nutrient Management, Code 590
Pest Management, Code 595
Trough or Tank, Code 614

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS

EMBANKMENT POND

SCOPE

This item shall consist of the clearing, excavation, backfill, concrete and other appurtenances required for the construction of the embankment and the disposal of all cleared and excavated materials for the water impoundment. Construction operations shall be carried out in such a manner that erosion, air, water and noise pollution will be minimized and held within legal limits as established by state regulations.

CLEARING AND GRUBBING

Pond Area. All trees and brush shall be cut as flush with the ground as practicable, and all such trees, brush, logs and other debris shall be removed from the pond site. Clearing shall be performed around the shoreline as specified.

Spillway and Borrow Areas. On areas from which fill materials are to be obtained, all trees, brush, logs, roots and other debris larger than 1 inch in diameter shall be removed.

The Embankment Site. All trees, brush and other debris shall be removed from the area on which fill is to be placed. All stumps and roots one inch in diameter and larger should be removed from the fill site to a depth of 12 inches.

Disposal of Cleared and Grubbed Material. All combustible material cleared and grubbed, from the site, shall be disposed of by burning, burying at approved locations or removing from the site. All burning shall conform to Florida laws and regulations. All noncombustible materials cleared and grubbed from these areas shall be removed from the site or buried with a minimum cover of 2 feet. Topsoil, when available, should be stockpiled at a convenient location for use on the embankment, emergency spillway and other disturbed areas to facilitate establishment of vegetative cover.

FOUNDATION PREPARATION

Surface Treatment. The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod, and debris. All channel banks and sharp breaks shall be sloped to no steeper than one horizontal to one vertical (1:1). All material containing excessive amounts of organic matter shall be removed. The surface of the foundation area will be thoroughly scarified before placement of the embankment material.

Topsoil. Topsoil excavated from the foundation area and from the emergency spillway and borrow areas shall stock piled and placed on the dam, emergency spillway and borrow areas to facilitate establishment of vegetation.

EXCAVATION

Excavation and Backfill of Cutoff Trench. The cutoff trench shall be excavated to the depths, bottom width and side slopes (minimum one horizontal to one vertical) shown on the plans. All standing water shall be removed from the trench and it shall be backfilled using thin layers (maximum 8 inches) to the ground surface with suitable material by the same methods herein prescribed for "embankment construction."

Excavation and Backfill of Stream Channels. Existing stream channels crossing the foundation area shall be deepened and widened as necessary to remove all stones, gravel, sand, sediment, stumps, roots, organic matter and other objectionable material and to accommodate compaction equipment. Side slopes shall be constructed no steeper than one horizontal to one vertical (1:1). All water shall be removed from the channels, and they shall be backfilled in the same manner as prescribed for the cutoff trench.

Spillway and Borrow Excavation. The completed spillway excavation shall conform as nearly to the lines, grades, bottom width and side slopes shown on the plans as skillful operation of the excavating equipment will permit. The channel bottom shall be constructed transversely level and the side slopes uniform. All borrow areas outside the pool area shall be graded and constructed in such a manner that they are well drained and protected from erosion by the use of diversions or other conservation measures. Side slopes of borrow areas shall be constructed in such condition that establishment of vegetation, mowing and maintenance operations will be facilitated.

Excavation in borrow areas within the permanent pool area shall be graded in such a manner that they are well drained and will provide the minimum specified depth of water at the normal water level. When specified, shoreline treatment shall be performed by cut or fill to develop the desired depth of flooded area around the normal pool.

EMBANKMENT CONSTRUCTION

Selecting, Placing and Spreading of Material. The fill material shall be free of all sod, roots, frozen soil, stones over 6 inches in diameter, and other objectionable material. The placing and spreading of the fill material shall be started at the lowest point of the foundation (cutoff trench) and the fill shall be brought up in approximately horizontal layers not exceeding 8 inches in uncompacted thickness. Special attention will be given to compaction in the cutoff trench where it joins the abutment slopes.

These layers shall be of approximately uniform elevation and shall extend over the entire area of the fill. Each layer shall be thoroughly compacted by at least two complete passes of the construction equipment over the entire surface area of each layer after the layer has been spread to the lift thickness. Special compaction equipment shall be used when the required compaction cannot be obtained by routing of the construction equipment.

The distribution and gradation of materials throughout the fill shall be such that there will be no lenses, pockets, streaks or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use material of varying texture and gradation, the more impervious material shall be placed in the upstream and center portions of the fill.

Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench or by keeping the drain at least 1 foot above the adjacent earthfill.

Selected drainfill and backfill material shall be placed around structures, pipe conduits, and antiseep collars at about the same rate on all sides to prevent damage from unequal loading.

Moisture Control. The moisture content of fill material shall be such that the specified compaction can be obtained with the equipment used. The moisture content of the fill shall be maintained within a range to:

1. prevent the bulking or dilatence of the material under the action of the hauling or compaction equipment
2. prevent adherence of the fill material to the equipment
3. ensure the crushing and blending of the soil clods and aggregation into a homogeneous mass
4. contain adequate moisture so that a sample can be hand molded.

The completed fill shall conform as nearly to the lines and grades, top width, and side slopes shown on the plans as skillful operation of the construction equipment will permit.

PIPE CONDUIT INSTALLATION

The pipe conduit barrel shall be placed on a firm foundation to the lines and grades shown on the plans. Selected backfill material shall be placed around the barrel and its component parts in layers not exceeding 4 inches in thickness. Each successive layer shall be thoroughly compacted by hand or power tampers. Heavy equipment shall not cross over the pipe conduit barrel until 2 feet of hand compacted material has been placed over the pipe.

Materials. All of the component parts of the principal spillway conduit including barrel, riser, trashrack or deep water release, anti-seep collars, support posts, braces and hardware for mounting shall be of the quality specified and constructed as shown on the plans.

Concrete. The work shall consist of furnishing, forming, placing, finishing and curing Portland cement concrete.

When concrete is used for footings under risers, anti-seep collars, and bedding for reinforced concrete pipe barrels, the mixture shall be not less than five bags per cubic yard. The consistency of the concrete shall be such as to allow the concrete to be worked into place without segregation or excessive laitance.

The components of the mix shall be as follows: A standard known brand, Type I Portland cement, washed sand and gravel. Clean water shall be used in the mix. (Suggested ratio in mix: 94 pounds cement (1 bag), 6 gallons. water, 170 pounds clean dry sand, 315 pounds dry gravel. Smaller batches, 1 part cement, 2 parts sand, and 3 parts gravel, and water at the rate of 1 gallon per 16 pounds of cement).

Concrete shall not be placed when the atmospheric temperature may be expected to fall below 40^{0}F at the time concrete is delivered and placed at the work site nor when it is expected to exceed 90^{0}F during placement. All exposed surfaces of concrete shall be protected from the direct rays of the sun for at least the first seven days. All concrete shall be cured by keeping it continuously moist for at least seven days after being placed or by spraying with two coats of curing compound when other concrete will not be bonded to the concrete surface. Concrete shall not be exposed to freezing temperature during the curing period.

Pre-Bedding. The strength of lightweight, flexible PVC and corrugated steel and aluminum pipe is highly dependent on the bedding and backfill. It must be carefully jointed together, bedded, and backfilled. The backfill to be used in the vicinity of the pipe should be the most impervious fine grained material available and have proper moisture content to assure good compaction around the conduit. The pipe conduit should be cambered to prevent breaking or joint separation when the dam is built. That is, the pipe should be laid essentially level to centerline of dam, then laid essentially straight to the exit end elevation. Then when the earthfill load is applied over the pipe, the pipe will flatten to a smooth uniform grade and tighten the joint. Flexible anti-seep collars should be used to avoid stress concentrations in the pipe as it deflects. The bottom of the bedding trench will be shaped as a minimum to fit the lower one third (120^0) of the pipe. Flexible anti-seep collars may be constructed of 6 mil or thicker plastic or rubber sheeting attached to the pipe with stainless steel clamps, waterproof tape, or closet flanges and caulk material to ensure water tightness. The flexible collars will be held in place during installation with wire or light wood framing. Proper inspection of the installation is essential, especially during the bedding of the conduit and backfilling adjacent to the conduit and anti-seep collars. All other requirements for installation of plastic pipe will be in accordance with NRCS conservation practice standard Subsurface Drains, Code 606.

Principal Spillways, Trash Racks and Fittings. The pipe and pipe connecting bands shall conform with the following specifications and requirements:

Corrugated Steel Pipe. ASTM A760, 762, 885 or Federal Specification WW,P,405; helical corrugated or close riveted annular corrugated; asphalt or polymer coated; and, watertight connections as specified below:

Rubber "O" Ring type: All types and diameters of pipe.

Flanged Type: All pipe diameters 12 in. and under.

Conventional Connecting Bands: All diameters annular corrugated pipe only. Twelve inch minimum band width with rods and lugs required.

Corrugated Aluminum Alloy Pipe. ASTM B745, 790 or Federal Specification WW,P,402; lock, or welded seam helical corrugated with watertight connections as specified above for corrugated steel pipe.

Steel Pipe. ASTM A120 standard weight (Schedule 40). Used pipe is satisfactory provided its wall thickness has not been reduced by corrosion.

Concrete Pipe. AWWA C300, C301, and C302, or ASTM C76 Class II with joint sealed with rubber gaskets. Requires concrete bedding (minimum 3 inches thickness) under bottom third of pipe.

Plastic Pipe. Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D1785 or ASTM D2241.

High Density Polyethylene Pipe. High density polyethylene Type III, Class C, Category 4 or 5 conforming to ASTM D1248 and D3350 and AASHTO M252 or M294, Type S.

Markings. Marking on plastic (PVC) pipe verifies product specifications and includes:

a. Manufacturer's name or trademark and product code.

b. Nominal pipe size (e.g., 6 inches).

c. Material code designation (e.g., PVC 1120, 1220).

d. Standard Dimension Ratio or schedule no. (e.g.,SDR-26, SCH. 40).

e. Pressure rating or pressure class (e.g., 160 psi).

f. Specification designation (e.g., D1785, D2241).

Antiseep collars are to be of materials compatible with the pipe and installed so as to be watertight. The pipe shall be installed in accordance with the manufacturer's instructions and to the lines and grades shown on the drawings.

Other Materials. Other materials used in the principal spillway system that are not specified will be as noted in the plans or drawings.

Inspection of Materials. All materials used in the fabrication and installation of the principal spillway, trash rack, valves and other fittings, shall be visually inspected prior to or during their installation to assure quality and integrity of material.

POLLUTION CONTROL

Construction operations shall be carried out so that erosion and sediment are controlled during construction, and air and water pollution are minimized. Best management practices (BMP) for construction shall be installed and maintained as needed and according to NPDES permit if required. BMP's consisting of silt fences, hay bale barriers, diversions, mulching, stream crossings, temporary vegetation, fencing and others may be appropriate to adequately control erosion and sediment during construction.

VEGETATION

Vegetation will be established as specified in the vegetative plan. The embankment, spillway, borrow areas and other non-impounded areas disturbed during construction will be seeded or planted to perennial non-woody vegetation and then mulched. A perennial vegetation filter strip at least 50 feet wide will be established immediately above the normal waterline of the impoundment area, when adequate vegetation does not exist. This filter strip will be a part of the vegetation process.

Temporary vegetation or mulching will be used after construction is completed until conditions are favorable for seeding and planting permanent vegetation.

NRCS conservation practice standard, Critical Area Planting, Code 342 shall be used for plant selection, seedbed preparation, liming, fertilizing, seeding and mulching for both temporary and permanent vegetation. Treated areas will be fenced when needed to protect the vegetation.

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS

EXCAVATED POND

SCOPE

This item shall consist of the clearing, filling, and/or excavation required for the construction of an excavated pond and the disposal of all cleared and excavated materials for the water impoundment. The construction operations shall be carried out to minimize erosion, air, water and noise pollution and maintain these within legal limits as established by state regulations.

CLEARING

All trees, brush and stumps shall be cut as flush with the ground as is practical and removed from the site and spoil areas before excavation is performed. All material cleared from the area shall be disposed of by burning or removing from the site. All burning shall conform to state laws and regulations.

EXCAVATION OR SPOIL

The completed pond, berms and spoil banks (spoil disposal) and waste material shall conform as nearly to lines, dimensions, grades and slopes shown on the plans or staked on the site as skillful operations of the excavating equipment will permit.

POLLUTION CONTROL

Construction operations shall be carried out so that erosion and sediment control during construction is addressed, and air and water pollution is minimized. Best Management Practices (BMP) for construction shall be installed and maintained as needed and according to NPDES permit if required. BMP's consisting of silt fence, hay bale barriers, diversions, mulching, stream crossing, temporary vegetation, fencing and others may be appropriate to adequately control erosion and sediment during construction.

VEGETATION

Vegetation will be established as specified in the vegetative plan. The berm, spoil banks and other disturbed areas will be seeded or planted to perennial, non-woody vegetation and then mulched. A perennial vegetation filter strip at least 50 feet wide will be established around the excavated pond.

Treated areas will be fenced when needed to protect the vegetation from grazing or traffic.